

# HIGH PRINT RATE MERGING AND FINISHING SYSTEM FOR PARALLEL PRINTING

## BACKGROUND

### 1. Field

[0001] The disclosed embodiments relate to image production and, more particularly, to a system and method for printing and finishing media.

### 2. Brief Description of Related Developments

[0002] Incorporated by reference, where appropriate, by way of background, are the following references variously relating to what have been variously called "tandem engine" printers, "cluster printing", "output merger" etc., for example, Xerox Corp. U.S. Patent No. 5,568,246 issued 10/22/96; Canon Corp. U.S. Patent No. 4,587,532; Xerox Corp. U.S. Patent No. 5,570,172 to Acquaviva; T/R Systems Barry et al U.S. Patent No. 5,596,416; Xerox Corp. U.S. Patent No. 5,995,721 to Rourke et al; Canon Corp. Fujimoto U.S. 4,579,446; Xerox Corp. Provisional Application No. 60/478749 filed 6/16/03 by Robert J. Lofthus, et al, Attorney Docket No. D/A3249P1, entitled "UNIVERSAL FLEXIBLE PLURAL PRINTER TO PLURAL FINISHER SHEET INTEGRATION SYSTEM; a 1991 "Xerox Disclosure Journal" publication of Nov.-Dec. 1991, Vol. 16, No. 6, pp. 381-383; and the Xerox 8/3/01 "TAX" publication product announcement entitled "Cluster Printing Solution Announced". By way of an

example of a variable input and output level output connector for a "universal" single printer to finisher interface there is noted a Xerox Corp. U.S. patent No. 5,326,093.

[0003] The latter is noted and incorporated as an additional possibly optional feature here, since various printers and third party finishers may have different respective sheet output levels and sheet input levels.

[0004] Cluster printing systems enable high print speeds or print rates by grouping a number of slower speed marking engines in parallel. These systems are very cost competitive and have an advantage over single engine systems because of their redundancy. For example, if one marking engine fails, the system can still function at reduced throughput by using the remaining marking engines. One disadvantage of existing cluster systems is that the output is not merged, meaning that an operator may have to gather the output of a distributed job from multiple exit trays. Another disadvantage is that redundant finishers may be required.

[0005] When creating a parallel printing system, feeding and finishing may be implemented in a number of different ways. For example, a single high speed feeder system could be used to deliver sheets to the parallel marking engines, or alternatively, each engine could have its own dedicated feeder or feeders. A similar situation exists on the output side. A dedicated finisher could be used for each marking engine, or the output could be combined into a single finisher. One disadvantage of presently available systems is that once configured, the feeding, marking, finishing systems, and the media paths between them are dedicated and not easily changeable.

[0006] Another problem arises from merging the output of multiple marking engines. Presently, the relatively lower speed output of each printing engine is merged into an accelerated, high velocity media path as shown in Figure 1. The path is accelerated in order to maintain an inter-document gap between sheets and to merge all the outputs into a single stream without slowing the outputs from the individual marking engines. The act of accelerating sheets to a different velocity may require a significant media path length, especially for accommodating large size media. If the sheets are accelerated to a high speed and re-circulation through one of the marking engines is required, for example, for duplex or multiformat printing, the sheets must be slowed to the marking engine speed which may require a significant length of media path, more complex drives, nip releases, etc. There are practical limits to the speed of the high velocity media path. In addition, the speed of the high velocity media path may be further limited by the capacity of the finishing equipment. For example, a system having a single finisher with a capacity of 200 pages per minute would require limiting the speed of the high velocity media path to that same number of pages per minute, or else would require routing sheets to another finishing location.

[0007] A system that could take advantage of any combination of feeding, marking, and finishing systems, and any combination of media paths would be advantageous.

#### SUMMARY

The disclosed embodiments are directed to printing and post processing media. In one embodiment, a system for printing

media is disclosed including a plurality of marking engines for outputting printed media in a stream, one or more finishing stations for post processing the printed media, and a first media path system operable to transport the printed media from two or more of the marking engines to one or more finishing stations such that the streams are merged and transported one on top of the other.

[0008] In another embodiment, a method of operating a printing system is disclosed including outputting printed media in multiple streams, transporting the printed media such that the streams are transported one on top of the other, and post processing the printed media.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The foregoing aspects and other features of the present disclosed embodiments are explained in the following description, taken in connection with the accompanying drawings, wherein:

[00010] Figure 1 is schematic diagram of a prior art high velocity media path;

[00011] Figure 2a is a schematic diagram of a printing system in accordance with the disclosed embodiments;

[00012] Figure 2b is another schematic diagram of a printing system in accordance with the disclosed embodiments;

[00013] Figure 3 shows an exemplary embodiment of a media path element in accordance with the disclosed embodiments;

[00014] Figure 4 shows another exemplary embodiment of a media path element in accordance with the disclosed embodiments; and

[00015] Figure 5 shows another embodiment of a media path using a right angle or "radial" integration approach.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[00016] Figure 2a and 2b illustrate systems incorporating features of the disclosed embodiments. Although the disclosed embodiments will be described with reference to the embodiment shown in the drawings, it should be understood that the disclosed embodiments can be embodied in many alternate forms of embodiments. In addition, any suitable size, shape or type of elements or materials could be used.

[00017] As shown in Figure 2a, a system 10 is generally a printing system that includes at least two marking systems 15a, 15b and a finishing system 20. A media path is provided such that the sheets printed by the two marking systems 15a, 15b can be merged, one on top of the other, at some point before delivery to the compiling station 25 of the finishing system 20. It should be appreciated that this merging function could take place in the media path upstream of the finisher, as shown in Figure 2a, or in the media path of the finishing system. In the embodiment shown in Figure 2a, the two marking engines 15a, 15b each have their own dedicated feeding systems 30a, 30b, but it should be appreciated that an alternate feeding system that enables sheets to be fed from one or more feeder units to either marking engine could also be used. The embodiment shown in Figure 2a shows 2 marking engines, however 3 or more marking systems could be used with

a media path that enables the sheets from all marking systems to be merged before compiling.

[00018] As shown in Figure 2b, system 100 is generally a printing system that includes a feeder system 105, a marking system 110, and a finishing system 115. Feeder system 105 and marking system 110 are coupled together by a media path 120, and marking system 110 and finishing system 115 are coupled together by a similar media path 125. Feeder system 105, marking system 110, and finishing system 115 may each comprise one or more feeder modules, marking engines, and finishing modules, respectively.

[00019] It is a feature of some of the disclosed embodiments to provide a media path that enables any of one or more feeder modules within feeder system 105 to deliver media to any of one or more marking engines within marking system 110. It is another feature of some of the disclosed embodiments to provide a media path that enables printed media from any of the one or more marking engines to be delivered to any of one or more finishing modules within finishing system 115. It is yet another feature of the disclosed embodiments to merge or stack printed media streams from the marking system on top of each other and to optionally feed the merged printed media as a group or set to one or more of the finishing modules.

[00020] Some of the disclosed embodiments thus provide a high level of routing flexibility. The disclosed embodiments also enable finishing and compiling at higher print rates than could otherwise be accomplished with a finisher that only handled handles one sheet at a time. For example, a finisher that uses tamping technology to compile sheets at maximum print rate of 150 ppm, may be able to compile sheets at

approximately 300 or 450 ppm if sheets were delivered to it in groups of 2 or 3.

[00021] In another embodiment, systems 10, 100 may operate to decrease a print rate of marking systems 15a, 15b, 110, in the event that heavyweight media, tabs, or other specialty stock is being used and may optionally operate without merging the outputs of marking systems 15a, 15b, 110.

[00022] Referring to Figure 2b, feeder system 105 generally operates to provide media 160 to marking system 110. As mentioned above, feeder system 105 may comprise one or more feeder modules  $130_1 \dots 130_n$ . The operation of feeder modules  $130_1 \dots 130_n$  may be coordinated together or in groups, or they may be operated independently. Feeder modules  $130_1 \dots 130_n$  may be capable of providing media 160 in various forms for use by marking system 110. For example, feeder modules  $130_1 \dots 130_n$  may provide media 160 in the form of paper, polymer, plastic, woven material, or any other type of media substrate suitable for use by marking system 110. Feeder modules  $130_1 \dots 130_n$  may provide media 160 in the form of individual sheets, continuous rolls, or any other form appropriate for marking system 110.

[00023] Marking system 110 is generally adapted to apply images to media 160. The operation of applying images to media 160, for example, graphics, text, photographs, etc., is generally referred to herein as printing. The one or more marking engines  $135_1 \dots 135_n$  of marking system 110 may utilize xerographic marking technology, however, any other marking technology may also be utilized as part of the disclosed embodiments. The one or more marking engines  $135_1 \dots 135_n$  may be controlled independently or they may be controlled in a

coordinated manner, either in groups or all together. Each marking engine  $135_1 \dots 135_n$  may generally include an image transfer function 140 for applying images to media 160 and a media transport function 145.

[00024] Finishing system 110 generally operates to compile and finish printed media 165. The one or more finishing modules  $150_1 \dots 150_n$  of finishing system 110 may generally include various devices for treating or handling printed media 165, for example, cutting, stacking, stapling, folding, inserting into envelopes, weighing, and stamping. At least one of the finishing modules  $150_1 \dots 150_n$  may utilize a tamping operation for aligning printed media 165 where the sides of the media are contacted by a perpendicular surface.

[00025] Finishing modules  $150_1 \dots 150_n$  are shown in this embodiment as being arranged in parallel, however, they may be arranged sequentially, in any combination of sequential and parallel arrangements, or in any other suitable manner. The operation of finishing modules  $150_1 \dots 150_n$  may be coordinated individually, in groups, or all together.

[00026] Media path 120 operates to deliver media 160 from feeder system 105 to marking system 110, and media path 125 operates to deliver printed media 165 from marking system 110 to finishing system 115. Media paths 120, 125 may comprise one or more media path elements  $170_1 \dots 170_n$  which may provide multiple routing options.

[00027] Figure 3 shows an exemplary embodiment of media path element 170. Media path element 170 generally includes two path sections 320, 325 that transport media in opposite directions along parallel paths. A third path section 330



enters media path element laterally at an intermediate location and "crosses" paths 320 and 325 and merges into and out of paths 320 and 325. A gate system (not shown) controls the media route through media path element 170. Path 320 includes input 310<sub>1</sub> and output 315<sub>1</sub>. Path 325 includes input 310<sub>3</sub> and output 315<sub>2</sub>. Path 330 includes input 310<sub>2</sub> and output 315<sub>3</sub>.

[00028] While in this example, media path element 170 is shown as having 3 path sections, 3 inputs, and 3 outputs, it should be understood that media path element 170 may include any number of path sections, inputs, and outputs. Media 160 may be accepted at inputs 310<sub>1</sub> ... 310<sub>3</sub> and selectively routed to any of outputs 315<sub>1</sub> ... 315<sub>3</sub>. Media path element 170 may be modular, for example, any number of media path elements 170<sub>1</sub> ... 170<sub>n</sub> may be coupled together to provide one or more selectively routable media paths. This configuration provides a high degree of flexibility in media routing.

[00029] As shown in Figure 2b, media path elements 170<sub>1</sub> ... 170<sub>n</sub> may provide a media path from any one of feeder modules 130<sub>1</sub> ... 130<sub>n</sub> to any one of marking engines 135<sub>1</sub> ... 135<sub>n</sub>. Media path elements 170<sub>1</sub> ... 170<sub>n</sub> may be utilized in media path 125 to provide a media path from any one of marking engines 135<sub>1</sub> ... 135<sub>n</sub> to any one of finishing modules 150<sub>1</sub> ... 150<sub>n</sub>. For example, one high speed feeder module could service multiple marking engines, or several feeder modules could supply multiple marking engines independently. Media path 120 is advantageous in that it does not rely on a single merged media path to supply marking engines 135<sub>1</sub> ... 135<sub>n</sub>. If one or more feeder modules 130<sub>1</sub> ... 130<sub>n</sub>, media path elements 170<sub>1</sub> ... 170<sub>n</sub>, marking engines 135<sub>1</sub> ... 135<sub>n</sub>, or finishing modules 150<sub>1</sub> ...

150<sub>n</sub> fails, media path 120 may still provide media pathways among functioning feeder modules, media path elements, marking engines, and finishing modules. This is particularly advantageous in parallel printing systems.

[00030] The modularity of media path element 170 may greatly simplify the design and development of printing system 100. This modularity also enables scalability of printing system 100, where feeder modules 130<sub>1</sub> ... 130<sub>n</sub>, marking engines 135<sub>1</sub> ... 135<sub>n</sub>, and finishing modules 150<sub>1</sub> ... 150<sub>n</sub> may be added or removed as desired.

[00031] Figure 4 shows another exemplary embodiment of a media path element 410. Media path element 410 may be similar to media path element 170 in that it may be modular, and may be capable of selectively routing media from any of a number of inputs to any of a number of outputs.

[00032] According to the disclosed embodiments, media path element 410 may also be operable to accept media from one or more inputs and stack the media such that more than one substrate may travel in parallel along the same path and to convey the stack to a particular output.

[00033] While the embodiment in Figure 4 is shown utilizing three media path elements 410<sub>1</sub> ... 410<sub>3</sub>, it should be understood that any number of media path elements 410 may be utilized. While each media path elements 410<sub>1</sub> ... 410<sub>3</sub> is shown as having three inputs 415, 425, 435 and three outputs 420, 430, 440, it should be understood that media path elements 410<sub>1</sub> ... 410<sub>3</sub> may have any number of inputs and outputs.

[00034] Referring to Figure 4, media path elements 410<sub>1</sub> ... 410<sub>3</sub> are coupled together such that output 440<sub>1</sub> of media path element 410<sub>1</sub> is coupled to input 425<sub>2</sub> of media path element 410<sub>2</sub> and output 440<sub>2</sub> of media path element 410<sub>2</sub> is coupled to input 425<sub>3</sub> of media path element 410<sub>3</sub>. Printed media 165 is introduced into input 415<sub>1</sub> of media path element 410<sub>1</sub> and is routed toward output 440<sub>1</sub>. In media path element 410<sub>2</sub> additional printed media 450 is introduced into input 415<sub>2</sub> and stacked or merged with printed media 165 from input 425<sub>2</sub> to form a first stack 455. First stack 455 is routed toward output 440<sub>2</sub>. In media path element 410<sub>3</sub> additional printed media 460 is introduced into input 415<sub>3</sub> and stacked or merged with first stack 455 to form a second stack 465. Second stack 465 is then routed toward output 430<sub>3</sub>. Alternately, second stack 465 may be routed to any number of additional media path elements and merged with additional printed media.

[00035] Traditional media path drive nips include high friction, elastomer drive rollers on one side of the media path, and lower friction, idler rollers on the other side. Since more than one sheet are transported through the media path of the proposed system, and in particular through the path sections of media path element 410, the drive nips 480, 481 of media path element 410 could optionally include driven, high friction drive rollers on both sides of the media path. This will help prevent the additional sheets in the media path from slipping due to baffle friction, as they are transported through the system.

[00036] It should be understood that media paths 120, 125 may include any number of media path elements 170, 410, in any combination. It should also be understood that media path

elements 170, 410 may be assembled in any sequential, parallel, or combination of sequential and parallel arrangement.

[00037] As can be seen, media path elements 410<sub>1</sub> ... 410<sub>3</sub> operate to merge or stack multiple media streams on top of each other and to convey the stack to a particular output. The stacked media may be delivered to another operation, for example, a finishing module 150<sub>1</sub> ... 150<sub>n</sub> (Figure 2b).

[00038] Media path elements 170, 410 may also be configured to selectively stack media so that media may be stacked in variable sets. For example, the output of marking system 110 (Figure 2b) may be stacked in groups of 3 sheets of printed media, and then later stacked in groups of 2 sheets of printed media. Any suitable stacking arrangement may be configured.

[00039] Media path elements 170, 410 may also be configured as buffers to temporarily hold images or media when a particular size group of sheets is not needed, and to deliver sheets to marking system 110 or finishing system 115 optionally smaller or larger groups as required.

[00040] This embodiment enables extremely high print rate compiling and finishing in parallel printing systems without requiring printed media 165 to be accelerated to a higher velocity, and without requiring a unique high speed finisher, finishing system or finishing module. Media may be printed in the proper sequence by one or more marking engines 135<sub>1</sub> ... 135<sub>n</sub> (Figure 2b) to achieve proper collation. Media path elements 410<sub>1</sub> ... 410<sub>3</sub> may operate to merge printed media 165 with some degree of alignment, for example, media path elements 410<sub>1</sub> ... 410<sub>3</sub> may align corresponding edges of printed

media 165 in first and second stacks 455, 465 to within approximately 2mm.

[00041] Figure 5 shows another embodiment using a right angle or "radial" integration approach for marking engines 510, 515. In this embodiment, marking engines 510, 515 have output paths 540, 545, respectively, that are initially perpendicular to each other. A device 520 operates to align the direction of output paths 540, 545 so that they have the same direction and velocity. The media output from marking engines 510, 515, shown in this example as printed sheets may then be merged or stacked utilizing the structures and techniques described above, and then may be routed to subsequent operations, for example, finisher 525, or tamping finisher 530.

[00042] Thus, the disclosed embodiments provide a high level of flexibility in terms of media routing where various components of a printing system may be coupled to selectively supply other components. This provides operational flexibility and redundancy, allows for high speed parallel operations, and greatly reduces the size and complexity of the media path because high transport velocities are not required.

[00043] While particular embodiments have been described, various alternatives, modifications, variations, improvements, and substantial equivalents that are or may be presently unforeseen may arise to Applicant or others skilled in the art. Accordingly, the appended claims as filed and as they may be amended are intended to embrace all such alternatives, modifications, variations, improvements and substantial equivalents.

[00044] What is claimed is: